# SY88973/SY89307/MIC3001-Based SFP Module

## TXRX_307_R0 Evaluation Board

## General Description

This evaluation board is an implementation of the SFP module in a different form factor with on board faults indicators (LEDs) and a DB-25 connector for serial communication. The design uses Micrel's MIC3001 controller, SY89307 VCSEL driver, and SY88973 limiting amplifier. A picture of the fully bonded board is shown below.

Data sheet and support documentation can be found on Micrel's web site at www.micrel.com.

## Related Support Documentation

- MIC3001 Data Sheet
- SY89307 Data Sheet
- SY89973 Data Sheet
- MIC3000/1 Software User's Guide

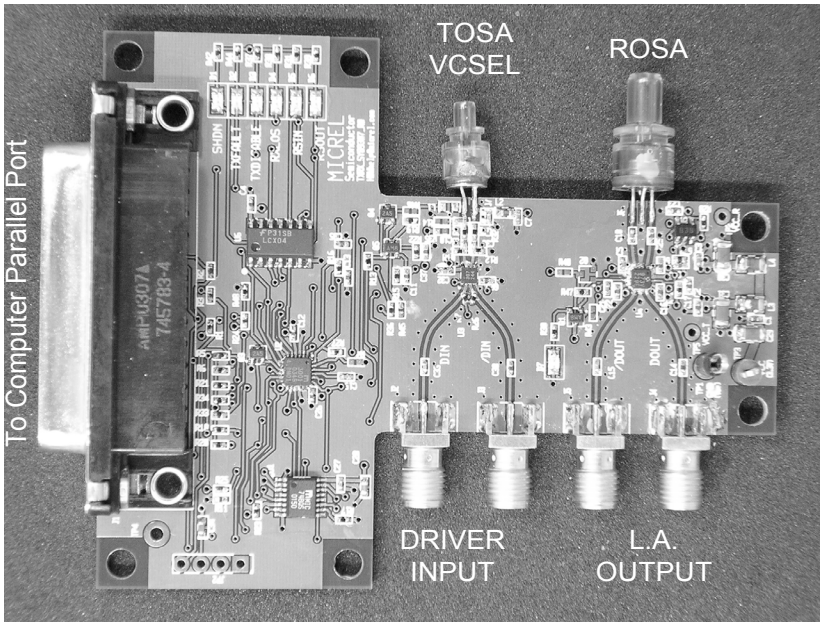
## Features

- Allows for easy and fast evaluation of Micrel's chipset for SFP module
- On board FAULTs indicators
- Easy access to the components for rework and different options implementation

## ICs Description

- SY89307: Low power, small form factor (2mmx2mm) VCSEL driver up to 2.5Gbps data rate.
- MIC3001: SFP module controller featuring digital diagnostic monitoring interface per SFF-8472 with internal/external calibration and full laser control with bias and modulation current compensation for temperature variations using look-up tables.
- SY88973: Multi-rate 155Mbps to 3200Mbps low sensitivity limiting amplifier.

## Evaluation Board



## Evaluation Setting

### Default Setting

The board comes with the driver set to drive a common anode VCSEL differentially. Table 1 shows the modifications to make on the board for different configurations.

| Configuration | Remove | Install |
|---|---|---|
| Common Anode Differential | R22, R45, R46, R24, R32 | R15, R19, R36, R48, C9, L2 |
| Common Anode Single Ended | R22, R45, R46, R24, R32, R8, C36 | R15, R19, R36, R48, C9, L2 |
| Common Cathode Differential | R15, R19, R36, R48, C9, L2 | R22, R45, R46, R24, R32 |
| Common Cathode Single Ended | R15, R19, R36, R48, C9, L2 | R22, R45, R46, R24, R32, R8, C36 |

**Table 1. Configuration Settings**

R15 = R22 = 3.3Ω
R45 = R46 = R24 = R32 = R19 = R36 = R48 = 0Ω
R8 =10-50Ω
C9 = C36 = 0.1μF

### TOSA and ROSA Installation

Check the pin out of the VCSEL and receiver and install them according to the diagrams shown on Figure 1.

### Receiver Sensitivity and Hysteresis Setting

#### *SY88973 Limiting Amplifier*

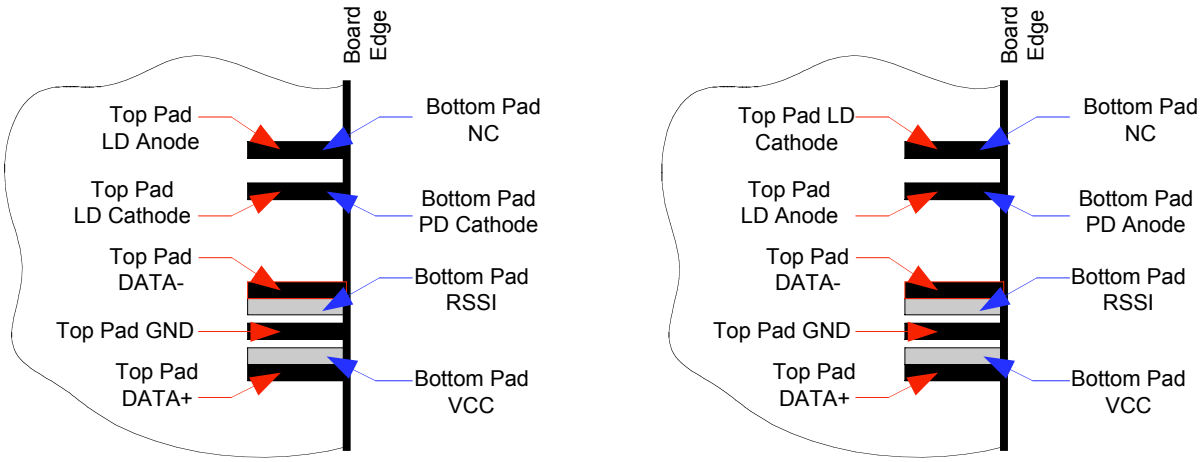
The SY88973 is the default limiting amplifier. It has a receive signal LOS indicator. To improve the hysteresis on the receive signal LOS, install R47 (0Ω) and R43. The combination of R43 and R41 will determine the sensitivity of the transceiver and hysteresis on the receive signal LOS. Refer to the application note entitled “Notes on Sensitivity and hysteresis in Micrel’s Post Amplifiers” available at:

http://www.micrel.com/product-info/app_hints+notes.shtml.

#### *SY88843 Limiting Amplifier*

The SY88843 can also be installed on the board. It has a signal detect SD indicator. To improve the hysteresis on the receive signal LOS, remove R47 (0Ω) and install R43, Q2, and R43. The combination of R43 and R41 will determine the sensitivity of the transceiver and hysteresis on the SD. Refer to the application note entitled “Notes on Sensitivity and hysteresis in Micrel’s Post Amplifiers” available at:

http://www.micrel.com/product-info/app_hints+notes.shtm




**(a) Common Cathode VCSEL** **(b) Common Anode VCSEL**

**Figure 1. Mounting of Laser and Receiver**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## Set-Up and Operation

Follow the step-by-step procedures, described below, to set-up the board safely and properly:

1. Connect the on board DB-25 connector to the parallel port of a computer.
2. Connect the differential input of the laser driver to DATA output of the pattern generator.
3. Use a multimode fiber jumper with appropriate connectors to connect optical output of the VCSEL to a VOA (variable optical attenuator) preset to 0dB attenuation.
4. Connect the output of the VOA to the optical input of the DCA, power-meter, or optical to electrical converter.
5. Pre-adjust the power supply to 3.3V, turn it off, and connect TP3 to $V_{CC}$ (3.3V) and TP5 to GND. Then turn the power supply ON. The total current drawn from the power supply should be less than 300mA.
6. Launch the MIC3000/1 software. The **MIC3001 Optical Transceiver Management IC** panel opens with **Panels** and **Help** grayed out and only **Utilities** can be run.
7. Refer to MIC3000/1 Software User's Guide for the detailed settings.
8. On the main window select **Utilities** to open the utilities panel, then select **SCAN** to read the address of the MIC3001 and **GET** to read the manufacturer ID, Device ID, and Die Revision. If there is a failure in reading one of these parameters, you cannot proceed further. If all the parameters are read correctly, close the **Utilities window** to return to the main window where the **Panels** and **Help** are no longer grayed out.
9. Select **Panels** to display the list of setting panels.
10. All the bits displayed on the panels can be read and/or modified on the panels or by accessing the registers directly by selecting **ALL REGISTERS**, enter the serial address, the register address, select **GET** to read the content or type a value and select **SET NEW** to write. In this procedure the bits are set on the panels.
11. Select **OEM CONFIG 0-2** to open the OEM configuration registers 0, 1, and 2 windows.
12. In **OEM Configuration Register 0** window, set **ENABLE/DISABLE** to DISABLE, **VMOD REFERENCE to VDD**, and **temperature zone** to **INTERNAL**.
13. In **OEM Configuration Register 1** window:
    a. Set **APC OP-AMP TYPE** to **COMMON EMITTER**.

Note: Set the selection bit to 0, 0 should correspond to EMITTER FOLLOWER, which should be displayed on the bottom and COMMON EMITTER on the top.

    b. Select the voltage to report in VINH:VINL.
    c. Set Feedback voltage source to 1.22V.
    d. If a common cathode VCSEL is used, set **FEEDBACK BIAS REF** and **RES TERMINATION** to **VDD** and **VBIAS DRIVE** to **SINK (PNP)**.
    e. If a common anode VCSEL is used, set **FEEDBACK BIAS REF** and **RES TERMINATION** to GND and **VBIAS DRIVE** to **SOURCE (NPN)**.
    f. Set **INTERNAL FEEDBACK RESISTOR** to an arbitrary value (1.6K for example).
14. In **OEM Configuration Register 2**, the MIC3001 address and look-up table offset can be modified. The look-up table covers 128°C. The temperature range for offset = 0 is 0° to +127°C.This range can be shifted down by 2x offset. The offset is set to. If offset = 15, the temperature range becomes –30° to +97°.
15. In **OEM Configuration Register 0** window, set **ENABLE/DISABLE** to **ENABLE**.
16. On **Panels** list select **OEM CONFIG 3-4** and select **EXTERNAL CALIBRATION** (default setting), **LOS COMPARATOR ENABLE, SHDN, RXLUT INPUT TEMPERATURE, and RSOUT**. If needed, later set **ISTART** to a different value to speed up the APC loop start-up during laser turn ON after a FAULT occurrence. Close the window to return to main window.
17. On **Panels** list, select **External Calibration**. Set all the **offsets** to 0 and **slopes** to 1. Set **RX_PWR(1)** to 1. These parameters might need to be changed later to correct the measured values (calibration). Return to the main window.

18. On **Panels** list, select **Temperature Compensation**. Load look-up tables for APC, Modulation, Bias current Fault, and End-of-Life from appropriate files. If no loading is done, the default value 0 is used for all the LUT. Return to the main window.
19. On **Panels** list, select **OEM settings**. Enter the desired DAC values between 0 and 255 for the displayed parameters then select **SET NEW**. Select **GET CURRENT** to make sure that the set values are written into the registers. Checking them can mask the faults. Return to the main window.
20. On **Panels** list, select **User**. Check **APC0** in the **USER CONTROL REGISTER** (default setting). All the other parameters can be checked later to verify their functionality. Return to the main window.
21. On **Panels** list, select **Result**. The values of the five monitored parameters as per SFF-8472 are now displayed. Type the **alarm** and **warning** thresholds and select **SET NEW LIMITS**. Select **GET CURRENT LIMITS** to check that the set values are written into the registers. Return to main window.
22. Set modulation current and bias current to get the desired output power and extinction ratio at the output of the VCSEL. Use **OEM Settings** panel or **TX Setup** panel to accomplish the following:
    a. In **OEM settings** window, set the bias by entering a value from 10 to 100 in **APC SET POINT 0** box and modulation by entering a value from 10 to 100 in MOD DAC setting box followed by SET new.
    b. In **TX calibration** window, set the bias by entering a value from 10 to 100 in **APCO (DEC)** box and modulation by entering a value from 10 to 100 in MOD DAC setting box followed by SET new.

After setting the new value for bias or modulation current, toggle **TXDISABLE/TXENABLE** on the main window.

23. At this step, there is no received power since no signal is applied at the input of the receiver.
24. Adjust the VOA to bring the optical power to the desired level at the input of the receiver. Then connect the output of the VOA to the input of the receiver using appropriate fiber jumper.
25. If the installed receiver has RSSI signal, a value (needs calibration) of the received power should be displayed now.
26. On **Panels** list, select **TX Setup** to calibrate the TX power. Measure the optical power at the output of the VCSEL and enter the value (in mW) in the **MEASURED TX POWER** box, then select **CALIBRATE**. The monitored value is adjusted to display the measured value by automatically changing the slope set in the **EXTERNAL CALIBRATION** window. Reconnect the VOA to the VCSEL and return to the main window.
27. On **Panels** select **RX Calibration**. Measure the input power to receiver at the output of the VOA and enter the measured value (in mW) in the **MEASURED RX POWER** box then select **CALIBRATE**. The monitored value is adjusted to display the measured value by automatically changing the slope set in the **EXTERNAL CALIBRATION** window. Reconnect the VOA to the receiver and return to the main window.
28. At this stage, the masked faults should be unmasked and if there is a fault indication try to find the cause of it and fix it to get the transceiver running fault free and try to measure the performance of the laser driver and post amplifier.


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## Laser Response Tuning

**Overshoot/Undershoot**

The damping resistors R8 and R9 installed in series with laser are 10Ω. This value might be tuned to a higher value to minimize or suppress any overshoot or undershoot on the optical signal out of the laser, but keep in mind that higher value damping resistors will lead to higher rise/fall time.

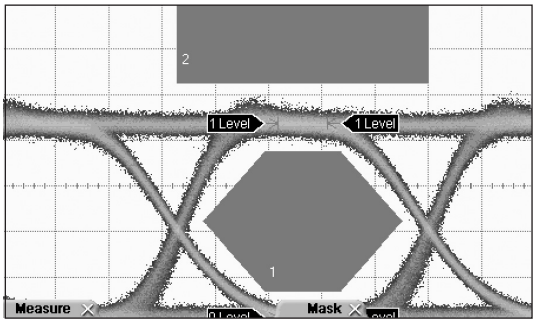
**Laser's Package Inductance Compensation**

A compensation network comprised of C10/R35 or C10/R14 can be used to compensate for the laser package inductance. R35 and R14 share the same pad on the board, so only one at a time can be installed. The values shown on the schematic are used for the symbol only. C10 should be a few pF and R35/R14 around 50Ω.

## Performance

Figure 2 shows an optical eye diagram obtained with Honeywell HFE4190-541 VCSEL (common anode) driven differentially:

**2xFC (2.125Gbps), PRBS $2^{23}$–1, ER = 10**
**Mask Set to 30%**




TIME (100ps/div.)

**Figure 2. Optical Eye Diagram**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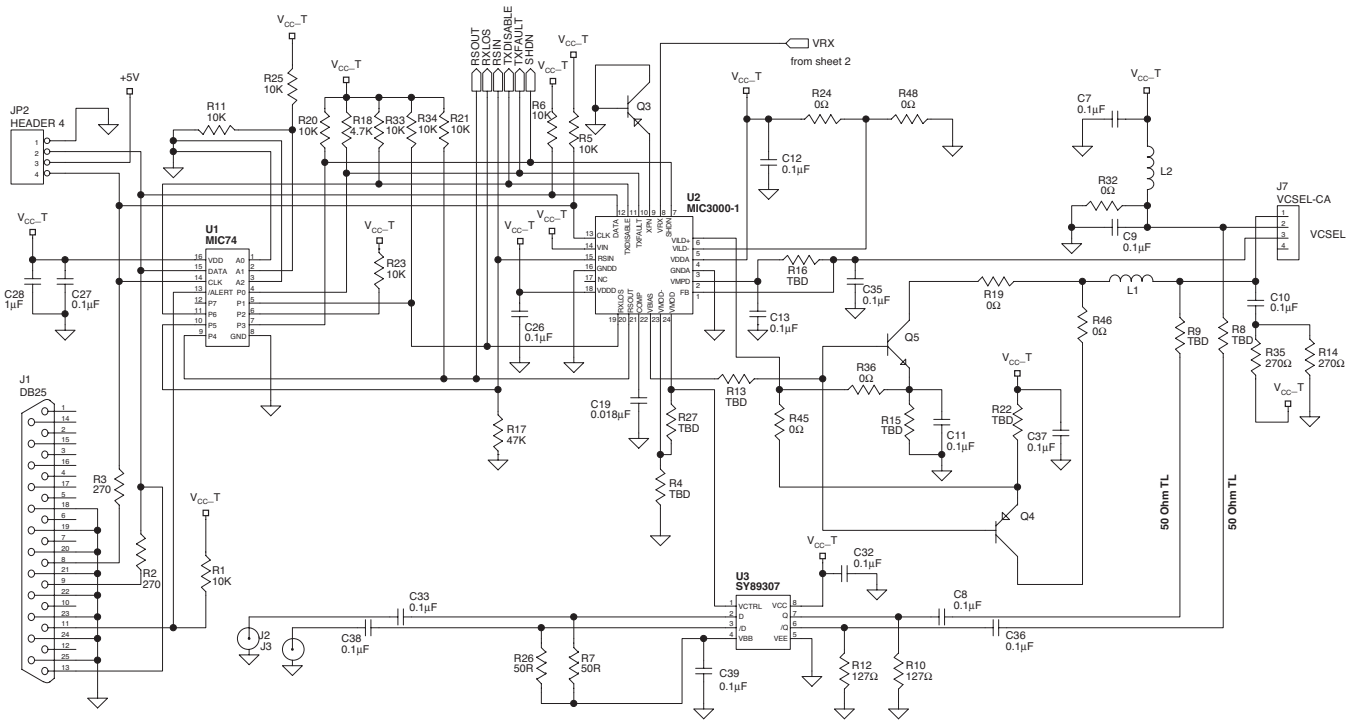


**Figure 2. Transmitter**

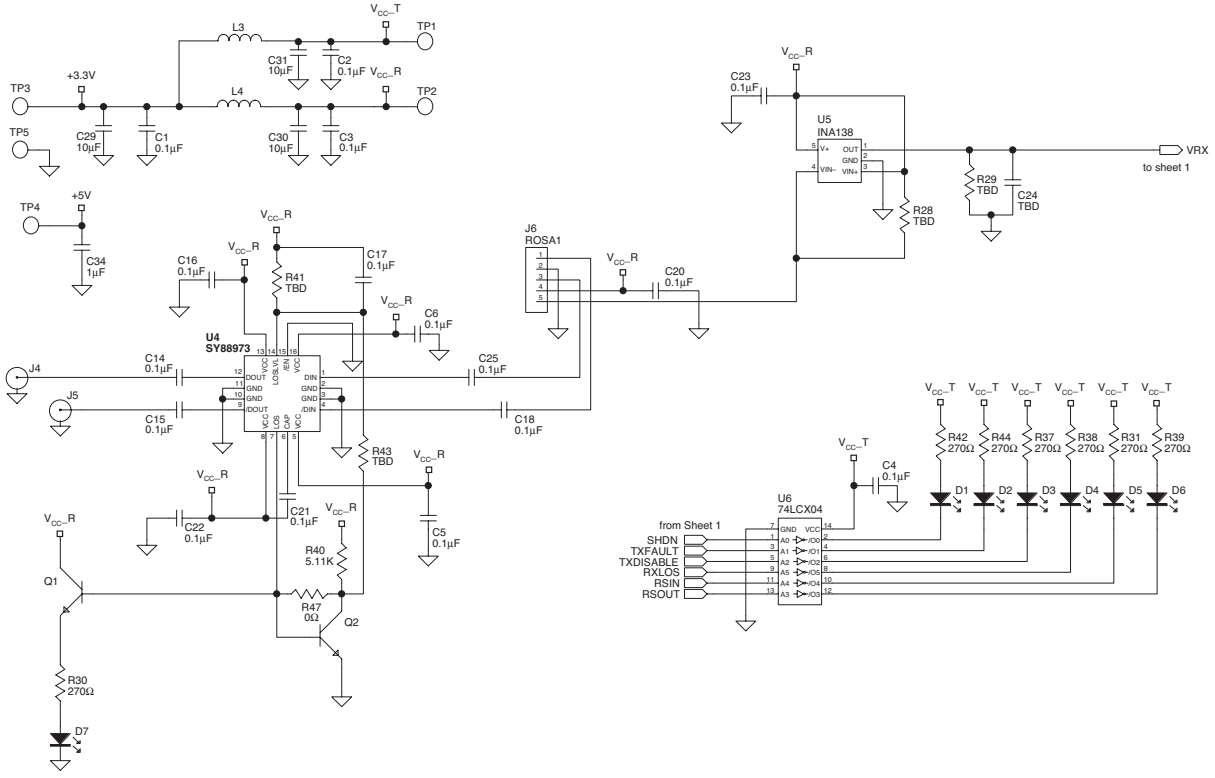


**Figure 3. Receiver**


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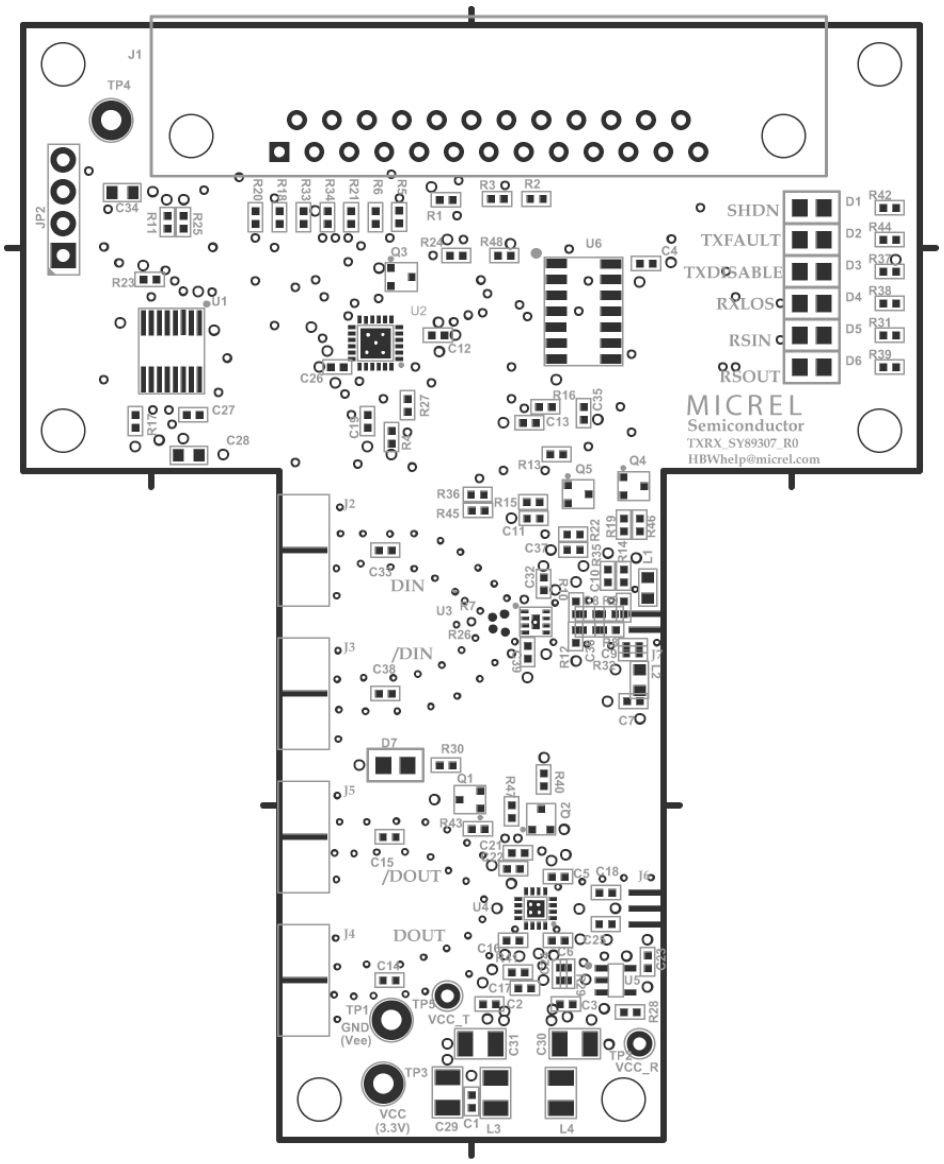
## PCB Layout/Assembly



# Bill of Materials

### Common Anode VCSEL Driven Differentially

| Item | Part Number | Manufacturer | Description | Qty. |
|---|---|---|---|---|
| C19 | | Vishay[1] | 0.1μF, 0402, ceramic capacitor | 1 |
| C1-C18,C20-C22, C24-27, C32, C33, C35-39, | | Vishay[1] | 0.1μF, 0402, ceramic capacitor | 39 |
| C28, C34 | | Vishay[1] | 1μF, 0603, ceramic capacitor | 2 |
| C29-C31 | ECSH0GY106R | Vishay[1] | 10μF, Y, Tantalium Solid Electrolytic Capacitor | 3 |
| D1-7 | 67-1636-1-ND | Digi-Key[2] | LED | 7 |
| J1 | 745783 | AMP[3] | Receptacle DB-25 R/A connector, 25 Position | 1 |
| J2-5 | 142-0711-821 | Johnson Components[4] | SMA End Launch Receptacle connector | 4 |
| J6 | D12M-9060-4 | Luxnet[5] | ROSA | 1 |
| J8 | 4190-521 | Honeywell[6] | VCSEL | 1 |
| L1-2 | BLM18HG102SN | Murata[7] | Inductor | 2 |
| L3-4 | IMC 0805 RK 122 J 01 | Vishay[1] | 1.2μH Ferrite bead inductor | 2 |
| Q1, Q5 | MMBT3904 | Fairchild Semiconductor[8] | General purpose NPN transistor (SOT-23) | 2 |
| Q3-4 | MMBT3906 | Fairchild Semiconductor[8] | General purpose PNP transistor (SOT-23) | 2 |
| R13, R16, R19, R27, R36, R48 | CRCW04020R00F | Vishay[1] | 0Ω resistor | 6 |
| R15 | CRCW04023R32F | Vishay[1] | 3.32Ω, 1% resistor | 1 |
| R8-9 | CRCW040210R0F | Vishay[1] | 10Ω, 1% resistor | 2 |
| R7, R26 | CRCW040249R9F | Vishay[1] | 49.9Ω, 1% resistor | 2 |
| R10, R12 | CRCW04021270F | Vishay[1] | 50Ω, 1% resistor | 2 |
| R2-3, R30-31, R37-39, R42, R44 | CRCW04022740F | Vishay[1] | 274Ω, 5% resistor | 8 |
| R18 | CRCW04024751F | Vishay[1] | 4.75kΩ, 5% resistor | 1 |
| R1, R5-6, R11, R20-21, R23, R33-34, R41 | CRCW04021002F | Vishay[1] | 10kΩ, 5% resistor | 11 |
| R17 | CRCW04024752F | Vishay[1] | 47kΩ, 5% resistor | 1 |
| TP3 | 5010 | Keystone[9] | Color Coded PCB test point | 1 |
| TP5 | 5011 | Keystone[9] | Color Coded PCB test point | 1 |
| U1 | **MIC74** | **Micrel**[10] | 2-Wire serial I/O Expander | 1 |
| U2 | **MIC3001** | **Micrel**[10] | Optical Transceiver Management IC | 1 |
| U3 | **SY89307** | **Micrel**[10] | VCSEL Driver | 1 |
| U4 | **SY88973** | **Micrel**[10] | 3.2Gbps Limiting Post Amplifier | 1 |
| U5 | INA138 | TI(Burr-Brown)[11] | High Side measurement Current Shunt Monitor | 1 |
| U6 | 74LCX04 | Fairchild[8] | Low Voltage Hex Inverter with 5V Tolerant Inputs | 1 |
| | **TXRX_307_R0** | **Micrel**[10] | Bare PCB | 1 |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**Notes:**

1. Vishay: www.vishay.com
2. Digi-Key: www.digikey.com
3. AMP: www.amp.com
4. Johnson Components: www.johnsoncomponents.com
5. Luxnet: www.luxnetcorp.com
6. Honeywell: www.honeywell.com/sensing/VCSEL
7. Murata: www.murata.com
8. Fairchild Semiconductor: www.fairchildsemi.com
9. Keystone: www.keystone.com
10. Micrel, Inc.: www.micrel.com
11. TI: www. ti.com

## Micrel Cross Reference

To find an equivalent Micrel part, go to Micrel's website at: http://www.micrel.com and follow the steps below:

1. Click on Dynamic Cross Reference.
2. Enter competitor's part number in the Dynamic Cross Reference field.
3. To download a PDF version of this information, click on the Cross Reference PDF tab.

## Application Hints and Notes

For application notes on high speed termination on PECL and LVPECL products, clock synthesizer products, SONET jitter measurement, and other High Bandwidth product go to Micrel Semiconductors' website at http://www.micrel.com/. Once in Micrel's website, follow the steps below:

1. Click on "Product Info".
2. In the Applications Information Box, choose "Application Hints and Application Notes."

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